SCIENCE.—SUPPLEMENT.

FRIDAY, MAY 14, 1886.

CROSS-FERTILIZATION OF PLANTS BY BIRDS.

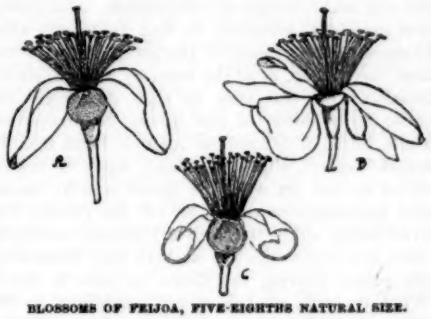
ADAPTATIONS for cross-fertilization exist in an almost endless variety throughout the vegetable kingdom, and have afforded a wide field for study and speculation to biologists. Many of great interest have been described by Hermann Müller as occurring in South American plants; and now the well-known South American naturalist, Fritz Müller, adds in *Kosmos* (1886, i. 93–98) a very remarkable discovery of adaptation to cross-fertilization by birds, — the first case of the kind, it is believed, that has been observed in the vegetable kingdom.

The flowers of the common European myrtle, with their delicate white corolla and crown of white stamens and simple pistil, are familiar to all. Very similar are the white flowers of the trees and shrubs belonging to the numerous species of the genera Campomanesia, Psidium, Myrcia, and Eugenia of the same family (Myrtaceae), occurring in great abundance in South America. Many of the species blossom in such profusion that the trees appear nearly white, and the pleasant odor that not a few give off attract bees and other insects in great numbers; and while in many others the flowers are not so conspicuous, and the perfumes not so evident, yet the pollen is easily transferred from flower to flower, and tree to tree, by the agency of insects.

In this uniformity among the genera and species a singular exception is found in the 'goiabo do campo,'— a not uncommon tree in the higher lands of Brazil, and widely known for its excellent fruit. The single species belong to the genus Feijoa; and its popular name, as well as its mode of growth and its foliage, recalls the wide-spread common guava-tree (Psidium pomiferum).

The flowers are found usually at the extremity of the twigs, or more rarely in the axils of the leaves, in groups of from two to five, on short stems. The leaves in whose axils the flower-stems, or the twigs bearing them, occur, are reduced to rudimentary bracts; and the flowers, for this reason, are more conspicuous than they would be were they enveloped by leaves, as is usual in the allied genera. A yet more especial adaptation to the means by which they are fertilized is the duration of flowering, which extends for months, during the entire spring, single blossoms appearing here and there over the tree.

The sepals form two pairs, — those of the one about six millimetres in length, and of equal breadth; of the other, twice as long and a little wider. In the unfolding of the blossom they are turned downwards, and present only the dark reddish-brown inner side. The petals at first are



BLOSSOMS OF FEIJOA, FIVE-EIGHTHS NATURAL SIZE.

about fifteen millimetres long and as many broad, firm and leathery, and arched outwards: the inner side, of a purplish-red color. Within a day they grow to double the length and breadth, and so roll up longitudinally that they form a tube not more than one-third of the width, the leaves of the two pairs rolling or turning in opposite directions.

Together with these changes in size and shape, there are others in color and taste. The external side of the petal, all that is now visible, becomes pure white, contrasting with the dark background of the sepals; and instead of being thickened and tasteless, or with a slight acrid taste, as is usual in so many of its congeners, like the clove and other species, it has now become soft and very sweet, and without any acridity.

The dark blood-red stamens, to the number of about fifty or sixty, are about eighteen millimetres in length, thickened and stiff, and expanding above into a crown more than an inch in diameter. The anthers lie horizontally, and liberate their bright yellow pollen nearly at the same time that the petals reach their complete development. The single pistil is likewise firm and stout, and extends above the plane of the anthers. As an unusual occurrence, there were found at one time

flowers in which one or more of the sepals had been transformed into petals, as shown in fig. B; and, from their evident relation to each other, the author notices the fact as deserving the attention of those who would speculate upon laws of variation and heredity.

From the description it will be seen that the flowers are conspicuous, having deep-yellow pollen, dark blood-red stamens and pistil, snow-white petals, and dark sepals, all unhidden by the foliage. But, notwithstanding this conspicuousness, the flowers are seldom visited by bees, there being, as was found, little or no nectar or honey to attract them. Even in cases where bees were observed upon the flowers, the prominent pistil did not readily admit of fertilization. The author was surprised, however, to find that soon after blossoming very many of the petals were severed near the middle, or at the base, by a single strong incision. By watching he soon discovered the cause to be birds of the genus Thamnophilus. These birds, of which the male is black and the female brown, alighted usually upon a branch above the one on which a flower was in bloom, and, reaching downward, bit off the petals; but, in so doing, either the neck or forehead invariably came in contact with the anthers, and brushed off the pollen, leaving the flower as seen in fig. C. Whether birds of this genus, especially in the more normal habitat of the tree in the higher lands of Brazil, are the only agency of cross-fertilization, or whether other birds share in it, remains to be discovered.

In Europe it is only exceptionally that birds are attracted by flowers. Sparrows sometimes bite off the flowers of the yellow crocus, and the bullfinch will pluck with inherited dexterity that portion of the under part of the primrose which contains honey. No adaptation has hitherto ever been observed where such mutilations of the blossom were of direct advantage to the plant, and the present example of Feijoa is therefore the more remarkable for the high degree of perfection which this adaptation has reached. Instead of the sweet petals being spread out for ornament alone, out of which the bird could pluck but a small portion, they become rolled up, thus permitting a larger part to be bitten off, and presenting greater attractions. The stout, firm anthers, and pistil, are likewise adaptive, insuring the clinging of the pollen to the feathers of the bird, and thus its ready transportation from one blossom to another.

How these adaptations have been brought about can scarcely be conjectured, as the genus is widely removed from the allied genera, and there are no intermediate forms.

PROFESSOR HUGHES ON SELF-INDUCTION.

The recent researches of Prof. D. E. Hughes, president of the Society of telegraph engineers and electricians, have been extended by him, and his latest results will be published in a forthcoming number of the *Society's journal*. We are enabled to give some account of these researches from an account published in *Engineering*.

The extra resistance of a wire during the 'variable period,' that is to say, when the electric current entering it is rising to its normal strength, has been shown by Professor Hughes to proceed from an extra current of opposite name self-induced in the wire. He finds, however, that there are cases in which this effect is reversed, so as to produce less resistance in the wire during the variable period. Such cases occur when extremely fine wires are being tested with powerful currents; for the steady current heats the wire, thus introducing an extra resistance. The induction-bridge of Professor Hughes enables him to study and analyze these effects, tracing them to their true cause.

Professor Hughes has lately been investigating the self-induction of coils, as well as of straight wires, and the following table gives his result:—

Coils formed of 3 metres of silk-covered copper wire 1 millimetre in diameter, each coil being 3 millimetres in diameter.	Comparative force of the extra currents.
One coil alone	100
Two similar coils in series	174
Two similar coils in parallel, but separated 5 centimetres from each other	55
Same two coils in parallel, but superposed	81
One single coil of thicker wire of exactly the same form, length, and resistance as the two coils in parallel	75

This table shows an increase of the self-induction when the two coils are in series, but not quite double the effect, as there is an increased or added resistance. This result is well known; but a more interesting result is obtained where the two coils are parallel and separate, giving 32 per cent less self-induction than when they are superposed, and 26 per cent less than that of a single coil of the same resistance. Professor Hughes traces this result to the reaction of contiguous coils on each other.

With regard to the self-inductive capacity of non-magnetic wires of different metals, but of the same lengths and diameters, Professor Hughes finds that when non-inductive resistances, say, of carbon, are added to the wires to bring them to equal resistance, there is apparently no difference in the self-inductive capacity of all the metals he has yet tried; but if, instead of adding a supple-

mentary resistance of carbon, the wires are taken of the same length and resistance, their diameters being different, he finds a marked difference in their inductive capacities. For instance: a pure copper wire, compared with a brass one of double the diameter, shows a much higher self-induction; and Professor Hughes remarks in this connection, that, as the diameter increases, the reactions of the current in the contiguous parts of the wire on each other become less. The following table gives some fresh values of the electromotive force of self-induction currents in wires and strips one metre long, that of a chemically pure copper wire one millimetre in diameter being taken as 100:—

Wires of the same diameter, but of different resistance, 1 metre in length.

Soft Swedish iron	500
Copper	100
Brass	65
Lead	50

Wires of the same resistance, but of different diameter, 1 metre in length.

Soft Swedish iron	400
Copper	100
Brass	88
Lead	81

Strips of the same width and thickness, but of different resistance, 1 metre in length, 12 millimetres wide, 1-10 of a millimetre thick.

Copper	60
Brass	48
Iron	45
Lead	85

Strips of the same resistance and thickness, but of different widths, 1 metre in length, 1-10 millimetre thick.

12	millimetres	wide	(copper)	60
42	"	"	(brass)	45
72	"	"	(iron)	39
96	"	"	(lead)	29

In the above table, wires of the same diameter follow in the order of their resistance, iron alone being the exception. The same order is preserved in wires of the same resistance, but of different diameters. In the latter case there is a nearer approach to equality, but they still show a difference of from 13 to 19 per cent; and, while the non-magnetic metals have increased their inductive capacity with increased diameter, iron has fallen 20 per cent: consequently wires of different metals of the same resistance have not the same inductive capacity, owing, probably, to the action of contiguous portions of the current, as Professor Hughes has already shown.

If we reduce the extra currents by employing thin sheets or strips, there is, in the case of iron, a still more remarkable difference, for in strips of different metals of the same width the force of the extra currents in iron is actually less than that in brass; and if we compare an iron strip with an iron or copper wire of the same resistance, we have, iron 500, copper wire 100, and an iron strip 45, or 55 per cent less than the copper wire.

In the case of wires a nearer approach to equality in inductive capacity is shown when they are of the same resistance, but in strips this is reversed; for here, when equality in resistance is produced by wider strips, the difference becomes greater, iron then having actually less inductive capacity than a lead wire of the same resistance. Professor Hughes attributes this remarkable result not only to the reactions of contiguous portions of the current being less in sheets or strips than in wires, but also to an imperfect formation of the circular magnetism which takes place in iron wires on the passage of an electric current. He has tried all forms of conductors, such as those of square, stellar, and tubular section; and all of them show a diminution of inductive capacity as compared with wires of solid circular cross-section. In solid conductors the maximum self-induction appears in those of circular section, and the minimum in wires formed into a flat strip.

While re-affirming his statement that the best lightning-rod is a flat strip of copper, or a galvanized iron strand wire, Professor Hughes has made experiments with American compound wires consisting of a steel core coated with copper, or a copper core coated with steel. He finds that the copper coating has an enormous influence in reducing self-induction in the steel. Without it the self-induction was found to be 350 as compared with a copper wire giving 100, whereas with it the self-induction was only 107, or 7 per cent more than copper alone. This effect is explained by the fact that the circular magnetism created by the passage of a current through an iron wire is produced chiefly on the exterior portion of the wire; and if this is of copper, it is practically suppressed. On the other hand, copper wire coated with steel has a greatly increased self-induction as compared with copper wire uncoated. It even has a higher self-induction than a solid iron wire, and its resistance in the variable period is proportionally greater than that of a soft iron wire. Professor Hughes has made numerous experiments on this point; and they all show, that, while copper in a straight wire or a single *wide* loop has a far lower inductive capacity than iron, it has, on the other hand, the property of being far more excited by the reaction of iron, so that a straight copper wire can be excited by this reaction to a degree greatly exceeding that of a straight iron wire under precisely the same conditions. Some of Professor Hughes's experiments illustrating this point may be cited, as they are of much practical importance. A

copper and an iron wire of equal resistance, 1 metre in length, were measured for inductive capacity and resistance, the capacity of the copper wire being taken as 100, and the iron being 400. The copper wire showed an increased resistance, during the variable period, of 8 per cent, as compared with 128 per cent for iron; but a great change took place when each of these was placed in the interior of an iron gas tube of sufficient diameter to allow of the wire being insulated. The force of the extra currents in the copper wire then increased 350 per cent, while in the iron they increased 8 per cent, the force of the extra currents being now, for copper 450, and for iron 433.

The influence of an iron tube on the resistance of the variable period was still more marked. The copper wire which, without the exterior iron tube, had only 8 per cent increase, now showed 934 per cent; or, by direct measurement, 1 metre of this wire, during the rapid rise and fall of the current in the variable period, had a resistance the same as 10.34 metres in the stable period, — a much greater difference than was obtained with iron wire, which only showed an increase of 22 per cent. Thus copper shows three times the sensibility to an iron sheath which iron does, a fact of importance in electrical engineering. Iron is much less affected in self-induction by exterior influence than copper. Copper coils are much more sensitive to iron cores within them than iron coils, and the resistance of a copper coil may be in the variable period far more than that of an equal iron coil, if an iron core react within it. It is this fact, however, as Professor Hughes points out, which enables copper coils to be so effective in transforming energy in 'secondary generators;' and he remarks that a dynamo having its electromagnet and armature wound with insulated iron wire, would, irrespective of its resistance, have an extremely low efficiency as compared with one wound with copper. As regards the resistance of either of those wires, Professor Hughes observes that there can be no doubt that the resistance of the armature of a dynamo, or, in fact, of any coil of wire, as measured during the stable period, gives no approximate indication of what its real resistance is during the period in which it is doing work. This remark bears out a recent suggestion to the effect that the resistances of conductors, apparatus, and standards, as measured by battery currents in the stable period, differ to some extent from their values when traversed by the rapidly fluctuating currents of a dynamo. A further investigation of the matter is required in order to find out its practical importance, if any.

The following table shows the influence of an iron tube surrounding a straight iron or copper wire compared with compound wires:—

Wires in iron tube, each 1 metre in length.	Comparative electromotive force of the extra currents.	Approximate comparative increased resistance during the variable period (that of the stable period being taken as 1.)
Copper wire 2 millimetres diameter, alone	100	1.08
Same wire insulated in the interior of the iron tube	450	10.34
Same joined in the tube at both ends	275	10.00
Same in contact with the tube throughout its length	200	7.83
Compound wire (copper interior with steel exterior)	325	4.35
Soft Swedish iron, 2 millimetres diameter, alone	400	2.28
Same wire insulated in the interior of the iron tube	433	2.78
Same joined to the tube at both ends	240	2.70
Same in contact with the tube throughout its length	215	2.60
Compound wire (steel interior, copper exterior)	107	1.20

This table shows that the iron tube has a much greater effect on the copper wire than on the iron wire, the effect in both cases being at its maximum when the tube is insulated from its central conducting wire; for, while the wire is in contact with its tube, there is evidently a shunt action, or eddy current, between the outer coating and the central portion. This Professor Hughes has measured by means of a telephone between the wires and its sheath, and also between two concentric sheaths. When the sheath is joined to the wire at both ends, the electromotive force of the extra current is reduced, but the resistance during the variable period is little altered. If, however, as in a coated wire, the wire and sheath are in contact throughout, there is a marked decrease in this resistance. Thus Professor Hughes is of opinion that the shunting effect takes place locally and probably transversely. The passage of an electrical current then takes place with less opposing resistance from self-induction than would be the case if there were no internal partial neutralization of the extra currents.

ORIGIN OF FAT IN ANIMALS.

Since the researches of Dumas, Milne-Edwards, and others on insects, and those of Persoz and Boussingault on geese, it has been established that the animal organism has the power of elaborating fatty matters. It was formerly believed that such

matters were received already formed with the food, and that the *rôle* of the animal organism was merely to accumulate them. The vegetable organism, it was thought, was alone able to form them.

In comparing the quantities of fat stored in the bodies of those animals experimented upon with those known to have been introduced with the food, they were found to be considerably greater. It was shown, that, of the thousand grams daily increase in weight of an ox, six hundred or more were due to an accumulation of fat, while the ingested matters contained less than half of that quantity; so that it is rendered certain that a large proportion, if not all, of the fat in the animal body, is due to sources other than fatty foods. What these sources are, is an important question, the answer to which has not been satisfactory. It has commanded much attention, especially in Germany, within late years, and has given rise to numerous controversies. It is a subject, also, of no little importance, since obesity in man is often an infirmity, and sometimes a grave disease. It will therefore be of interest to present such facts, in connection therewith, as have been so far experimentally demonstrated, as given by A. Sanson in the *Revue scientifique*.

Pettenkofer and Voit kept during a number of days, in a suitable respiration apparatus, a dog which received daily given quantities of dried starch and fat, and ascertained that the dog eliminated, under the form of carbonic acid, not only all the carbon of the ingested starch, but also a portion of that of the fat. It was therefore concluded that the starch thus decomposed did not serve in the formation of the fat. This formed the basis of a theory, on Voit's part, that the formation of fat was due to the reduction of albuminoid matters by the oxygen of respiration. According to this theory, the alimentary substances which we call carbohydrates — that is to say, starch, glycogen, sugars — take no part whatever in the formation of fat. These are decomposed in the organism, furnishing material for the animal heat, and resolving themselves into carbonic acid and water. The albuminoid matters — the proteines — are only in part thus decomposed, and furnish, besides, urea and fat.

This theory of Voit, which was in reality a very ingenious hypothesis, was immediately accepted throughout Germany, though Henneberg showed by chemical calculation that 100 grams of albumen thus used would not furnish more than 51 grams of fat in addition to 33 of urea and 27 of carbonic acid. It is necessary to remark, however, that, in the numerous experiments performed by Voit and his disciples in support of this hypothesis, they were not able to verify it directly. It is impossible, in fact, to sustain the life of an animal nourished exclusively by albumen.

Taking as a point of departure the data of Henneberg's calculations and the facts established by the experiments, it has not been difficult to show that Voit's hypothesis is inadmissible by reason of its impossibility. The geese upon which Persoz experimented were found to have formed over 4,000 grams of fat, while their food, completely deprived of fat, contained but 1,400 grams of proteine, — a quantity sufficient to form but a little more than 700 grams of fat. Other experiments of the same nature show the impossibility even in a more striking degree. A cow which gained at the rate of 1,600 grams per day stored up daily nearly 1,000 grams of fat, but an analysis of the food with which she was supplied showed only sufficient albuminoid matters to furnish about half that quantity.

These and other experiments have established reasons, now generally received, for the belief that herbivorous animals do not depend upon albuminous foods for the sources of fat, but that the fat is in a large part derived from the carbohydrates.

Very lately Rübner has repeated the researches of Pettenkofer and Voit, and reached opposite results. He placed in the respiration apparatus a small dog weighing a little more than six kilograms, and gave it food composed of 85 grams of starch, 100 grams of cane-sugar, and 4.7 grams of fat. During ten days, in which it was kept under these conditions, it was found to have eliminated 87 grams of carbon. The entire quantity of carbon introduced by the food was 176 grams, of which 89 were retained in the organism, and served in the formation of fat, 76 of which must have been derived from the carbohydrates. From these facts he concludes that the carbohydrates are demonstrated to be a source of fat in the carnivores as well as in the herbivores and omnivores. These researches of Rübner destroy absolutely the value of those by Pettenkofer and Voit; and one can feel assured that the German theory of the dependence exclusively upon albuminoid matters in the formation of fat in the animal organism will no longer obtain acceptance. In these organisms, as in the vegetable, the fatty matters are formed by the carbohydrates furnished in abundance in the food.

No more definite conclusions, however, in regard to the proper composition of food to produce fattening, can be reached from a knowledge of these facts. In alimentation every thing depends upon digestion. Every thing must be adapted to

the individual aptitude, and the proportions of carbohydrates and albuminoid matters must bear mutual relations dependent more or less upon physiological processes. Too strong or too feeble, as regards the digestive power of the individual considered, the proportion of the carbohydrates exerts an influence either upon its own digestibility or upon that of the albuminoids which accompany it; and in either case it has a depressing effect upon digestion. But, as regards a regimen preventive or remedial of obesity, the case is different. It is evident, that, if the formation of fat is dependent upon carbohydrates, a diet composed largely of them, so often practised, can only be an error so far as obesity is concerned.

A DARING ECONOMIST.

This is a day of free lances in political economy. Its doctrines, its premises, its methods, are being subjected to every conceivable kind of criticism; but, of all the kinds, that represented by Mr. Patten's book is perhaps the rarest. He adopts the deductive method of English political economy, and in the main adopts also its premises; but by throwing special emphasis on such of these premises as he conceives have been insufficiently borne in mind, as well as by insisting on some others which he himself introduces, he arrives at most important conclusions very much at variance with those commonly accepted. But it is not so much this position which we have just outlined that makes the book somewhat exceptional, as the fact that Mr. Patten unquestionably understands the doctrines which he criticises. Not only does he understand them, but he gives ample evidence of such logical acumen and practical insight as might fit him to contribute to the improvement and extension of economic knowledge. Yet we are compelled to say that his book, on the whole, is most unsatisfactory; that while a reader who is well versed in economic theory, and who keeps himself constantly on the guard against the author's calm confidence in the completeness of his own argument, may find in it some suggestions which would repay attentive study, to the general reader it is full of snares and pitfalls.

We have touched upon the secret of the author's failure to produce a sound contribution to economic criticism. He seizes upon a feature which seems to him to have been slighted by previous writers; he drags it to the light, and wishes to compel a recognition of its importance in order to give the theory a completeness which it did not before possess; in his eagerness to do this, he comes to look upon his own supplement as the complete doctrine; and what in due subordination to the old teachings might have been a useful idea, becomes in this way a source of confusion and paradox. The author, moreover, exhibits a large share of that quality which has so frequently destroyed the utility of economic writing, — a disposition to exaggerate the differences between his own views and those of previous writers, — and, in his ardent pursuit of the consequences of a pet notion or discovery, loses sight of the principles which he elsewhere shows he has understood. The only safeguard against defects of this sort is a profound sense of one's own liability to err in matters of so subtle and complicated a nature as those with which our author deals, and such a feeling of respect for the great thinkers of the past as would compel one to examine a question most carefully from every point of view before deciding that they were in the wrong. This is not the spirit that animates Mr. Patten: his book is full of bold statements of fact and theory, for which the author seems to think that no further justification is necessary than that they fit in easily with the general considerations which, from his point of view, are most prominent. The result is, that, in addition to a sketchiness and incompleteness quite inconsistent with the weighty character of the subjects discussed, the book is marked by logical oversights of the gravest nature, which almost or quite neutralize the effect of the author's ability.

To justify this estimate of his book by an examination of the several arguments advanced by Mr. Patten would require an amount of space not much less than that occupied by the book itself. We must confine ourselves to one or two illustrations. The first chapter is devoted to a criticism of the Ricardian doctrine of rent. The principal objection here advanced against the theory rests on the fact that the extension of the field of cultivation requires an initial expenditure for clearing the land and fitting it for agriculture. This expenditure will not be incurred unless the owner can expect to receive as rent the ordinary profit on his initial expenditure of capital; but, the expense once incurred, the land will not be withdrawn from cultivation as long as it can merely yield the usual return for the labor and capital annually expended upon it. "It is clear, therefore," says Mr. Patten, "that the laws which regulate the bringing of new lands into cultivation, and those according to which land will be withdrawn from cultivation, are very different, and that there is a large margin within which the

The premises of political economy; being a re-examination of certain fundamental principles in economic science. By Simon N. Patten. Philadelphia, *Lippincott*, 1885. 12°.

price of food may vary without a change in the quantity produced." A little reflection will show that there is a fatal oversight in this argument. It is true that people will not incur a considerable expense in preparing new land for cultivation unless the price of produce is sufficient to enable it to pay rent; but there is no reason whatever to suppose that the land so brought into cultivation is the worst land in use. There might be a considerable fall in the price of food before the land last brought into use at great expense was thrown out of cultivation; but other and worse land would be thrown out of cultivation, or, what is the same thing economically, it would be less completely cultivated. If the Campagna were drained, no one supposes it would be the worst land in Italy; and, although a considerable fall in the price of Italian produce might afterwards take place without throwing the Campagna out of cultivation, this is not the same as saying that no land in Italy would be thrown out of cultivation. Mr. Patten thinks that the consideration of the expense of bringing new land into cultivation shows that there is no land which does not pay rent: in reality it merely shows that what is chronologically the last land to be cultivated is not always the land which pays no rent. In this, no Ricardian will be disposed to quarrel with him.

Strange to say, Mr. Patten, throughout this chapter, altogether ignores the possibility of reducing production by applying less capital to land, which is economically equivalent to withdrawing bad land from cultivation. In one of the last chapters he denies the truth of the law of diminishing returns; the law, namely, that after a certain point additional applications of labor and capital to a given portion of land yield a smaller return than former applications did. If Mr. Patten's position on this point were correct, the Ricardian theory would be sadly shaken. Mr. Patten fancies the true law to be that of limited returns, not diminishing returns; and, this fancy having taken hold of his mind, he devotes the main part of a chapter of thirty pages to trying to show that "the proportional return might increase up to a point beyond which no additional return could be obtained by any amount of labor." This is as much as to say that it would pay a farmer to apply all the care and all the expense required for fertilizing, draining, watering, and so forth, which was requisite for getting from the soil the largest amount of produce it was physically capable of producing. The position is disproved by the practice of every plain farmer, and by the experience of every 'model' farmer; and only the fatuity of a man in love with his own 'discovery' can account for Mr. Patten's curious effort to prove the contrary. In point of fact, he does not always bear in mind what it is that he is contending against, as when he says (p. 160), "If no other result were obtained from improved processes than this better utilizing of labor, this result would more than counteract any tendency there may be towards diminishing the return from agriculture." This is not in the least pertinent to the question; what economists assert is, that, with *given* processes, capital and labor applied to the soil beyond a certain point produce diminishing proportional returns.

The third chapter is devoted to a consideration of the law of population. One of the worst cases of easy-going refutation which occur in the book is furnished by the way in which Mr. Patten disposes of the method by which Malthus arrived at his conclusion. "He found that in new colonies, where the tendency has the fewest checks, population frequently doubles itself in twenty-five years, and then concluded that this rate of increase represented the natural force of the tendency, and that this was the rate at which population always tends to increase. There are many objections to this method of reasoning which will quickly appear when we apply it to the investigation of other subjects. . . . By the same method of reasoning we could prove that all men are natural drunkards, cannibals, adulterers, and murderers, since we find communities in various parts of the world where drunkenness, cannibalism, etc., are common." A schoolboy ought to perceive the difference between the two cases. What Malthus found was, that men of the same race, the same civilization, the same religion, the same traditions, multiplied at a much more rapid rate when placed in circumstances which permitted of the easy support of an increasing population than they did when living in an old and thickly settled country. The differences in the rate of increase were observed in the case of like peoples — often of the same people — in different circumstances; and it is ridiculous to put this on a level with a comparison between totally different peoples. If Mr. Patten had reflected that Malthus was neither a fool nor a vain man, but a man profoundly impressed with the importance of arriving at the truth concerning the law of population, he would have been slow to suppose that Malthus' position could be so easily overthrown: and if, after writing his chapter, he had carefully re-read his Malthus, he would have found that most of his criticisms had been very thoroughly answered by Malthus himself.

We shall look at one more example of the way in which Mr. Patten, in spite of understanding an economic law, goes astray through an unques-

tioning confidence in any apparent correction of it which may occur to him. He says that economists justly call attention to the waste of labor and capital caused by protection, but that they omit to notice a precisely similar waste, on a much larger scale, which is produced by free trade. To illustrate his point, he says, that, if Portugal has an advantage over France in the production of oranges, then, if a protective duty caused the planting of a few orange-groves in France on land which might have been more productively employed otherwise, economists would cry out against the waste. But the same effect may be brought about by free trade, if the world's demand for oranges is so great that the appropriate land of Portugal and similar countries is insufficient to supply it; the French land is then brought into requisition through the operation of free trade; and yet the economists make no outcry against it, says Mr. Patten, though the land is as surely diverted from its best use as it would be by a protective tariff. But precisely here is Mr. Patten's fallacy. There is no natural unit for comparing oranges with any thing else, as grapes, for example. What is meant by saying that on a given piece of land we can raise more grapes than oranges? Simply that the crop of grapes has more commercial value than that of oranges. When the demand for oranges has increased, the same quantity of oranges has a greater value than before, and the land is now better adapted for oranges than for grapes. Mr. Patten forgets that the Frenchman could still raise grapes as before: he prefers to raise oranges because the world at large will give him more for them than for the grapes. Mr. Patten may, indeed, reply, that, in point of fact, the grapes were capable of doing more good to the world than the oranges; but economists do not assert the contrary of this, or pretend that production is regulated by any absolute standard of utility. They know very well that people do not produce what is best for their fellows, but what their fellows most desire.

The title of Mr. Patten's book does not convey a correct idea of its contents, for it deals quite as much with questions of social improvement as it does with the primary laws of political economy. If we look in it, not for fundamental criticism, but for suggestions of additions to economic theory, and still more of improvements in economic practice, we may find, as already intimated, a number of things that would well repay attention. The importance of attending to the results of different economic arrangements in determining the character of the individuals who will survive and perpetuate their kind is made justly prominent throughout the book, and is probably its most valuable feature. It is not, however, carefully and impartially worked out, but is everywhere intermingled with the misleading criticism of economic doctrines which we have endeavored to characterize. In the discussion of free trade, Mr. Patten rightly calls attention to the importance of inquiring into its effects on distribution, the effect on production alone not being decisive of its desirability; and in various parts of the book there are suggestive remarks on the bad influence of a low rate of interest upon the chance which the poorer classes have of improving their condition. But both in discussing these matters and in proposing remedies, the author is almost always content to follow out the consequences of a single idea, instead of giving the subject that sober and comprehensive consideration without which no discussion of this nature can be useful, except by way of suggesting to others who are more careful, and more free from prepossessions.

The annual report of the North Carolina experiment-station for 1885 deals almost wholly with fertilizers and soils; but an experimental farm is about to be established in connection therewith, so that henceforth greater attention will be devoted to other less strictly chemical subjects. The station was established chiefly to give protection to the farmers of the state in the purchase of fertilizers, and its utility seems proved by the marked increase in value of the fertilizers in the market, and the rapid decrease of their actual cost price. Among the fertilizers to which attention was directed, are cottonseed-hull ashes; and it is of interest to note that the total possible annual output of these ashes in the United States is estimated at over twenty-five thousand tons, valued at over eight hundred thousand dollars, though less than half this amount has hitherto been actually obtained. The vast quantities of phosphatic rock lately discovered in the state have drawn attention to the possibility of utilizing the pyritic deposits for the obtaining of sulphuric acid, to be used in the manufacture of fertilizers. A report by Mr. A. Winslow advances the opinion that the plan is deserving careful attention. Should it prove practical, Carolina, as well as other southern states, will be benefited very materially in its agricultural industries.

— It is said that experiments have been successfully made on the Indus valley railway in running locomotives fired with petroleum, and that it seems likely that the frontier railway-engines will before long derive their fuel from the oil-wells near Sibi.